

WHAT IS CLAIMED IS:

1. A ring interconnection network system comprising a plurality of ring networks which have a plurality of nodes and a transmission line connecting these nodes in a ring and a plurality of connection parts which connect the plurality of ring networks to each other, said ring interconnection network system comprising:

10 a first self-healing function which, when a failure has occurred in said ring networks, forms a shortest communication route to avoid the failure;

a second self-healing function which, when a failure has occurred in said connection parts, forms a communication route to avoid the failure; and

15 switching control means for causing said first self-healing function and said second self-healing function to function in cooperation with each other without contradiction.

2. The ring interconnection network system according to claim 1, wherein said second self-healing function forms routes for transmitting the same signal in at least two of said plurality of connection parts beforehand and, when a failure has occurred in the connection parts, switches between these routes to form a communication route for avoiding said failure.

3. The ring interconnection network system according to claim 2, further comprising:

a first and a second ring network each of which includes a plurality of nodes including a first and a second interconnection node and a transmission line connecting these nodes in a ring;

5 a first interconnection line which connects a first interconnection node of said first ring network and a first interconnection node of said second ring network to each other; and

10 a second interconnection line which connects a second interconnection node of said first ring network and a second interconnection node of said second ring network to each other, wherein

15 said second self-healing function gives the first interconnection nodes of said first and second ring networks the right of selecting traffic from either said transmission line or said interconnection line to form routes for transmitting the same signal in said first and second interconnection lines.

20 4. The ring interconnection network system according to claim 3, wherein,

25 in a case where a traffic switching request has occurred in a segment other than the segment between said first and second interconnection nodes in said first ring network and the place where the request has occurred relates to a path interconnecting said first and second ring networks,

said second self-healing function, when said first

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self-healing function has operated according to said request, transfers said right of selecting traffic from said first interconnection node to said second interconnection node in said first ring network.

5 . 5. The ring interconnection network system according to claim 3, wherein,

in a case where a traffic switching request has occurred in the segment between said first and second interconnection nodes in said first ring network and  
10 the place where the request has occurred relates to a path interconnecting said first and second ring networks,

said second self-healing function, when said first self-healing function has operated according to said request, transfers said right of selecting traffic from said first interconnection node to a node which terminates said path.

6. The ring interconnection network system according to claim 3, wherein,

20 in a case where traffic switching requests have occurred in a segment other than the segment between said first and second interconnection nodes and in said second interconnection line in said first ring network and the places where the requests have occurred relate  
25 to a path interconnecting said first and second ring networks,

said second self-healing function, when said first

self-healing function has operated according to said requests, transfers said right of selecting traffic from said first interconnection node to said second interconnection node in said first ring network, and

5           the second interconnection node selects traffic from said first interconnection line.

7. The ring interconnection network system according to claim 2, further comprising:

10           a first and a second ring network each of which includes a plurality of nodes including a first and a second interconnection node and a transmission line connecting these nodes in a ring;

15           a first interconnection line which connects a first interconnection node of said first ring network and a first interconnection node of said second ring network to each other; and

20           a second interconnection line which connects a second interconnection node of said first ring network and a second interconnection node of said second ring network to each other, wherein

25           said second self-healing function gives the first interconnection node of said first ring network and the second interconnection node of said second ring network the right of selecting traffic from either said transmission line or said interconnection line to form routes for transmitting the same signal in said first and second interconnection lines.

8. The ring interconnection network system according to claim 7, wherein,

in a case where a traffic switching request has occurred in a segment other than the segment between  
5 said first and second interconnection nodes in said first ring network and the place where the request has occurred relates to a path interconnecting said first and second ring networks,

10 said second self-healing function, when said first self-healing function has operated according to said request, transfers said right of selecting traffic from said first interconnection node to said second interconnection node in said first ring network.

15 9. The ring interconnection network system according to claim 7, wherein,

in a case where a traffic switching request has occurred in the segment between said first and second interconnection nodes in said first ring network and the place where the request has occurred relates to  
20 a path interconnecting said first and second ring networks,

25 said second self-healing function, when said first self-healing function has operated according to said request, transfers said right of selecting traffic from said first interconnection node to a node which terminates said path.

10. The ring interconnection network system

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according to claim 3, further comprising:

network management equipment which provides monitoring control of the system; and

means for, when said right of selecting traffic has been transferred between nodes as a result of the occurrence of a traffic changing request, notifying said network management equipment about to which node the right of selecting traffic has been transferred.

11. The ring interconnection network system according to claim 7, further comprising:

network management equipment which provides monitoring control of the system; and

means for, when said right of selecting traffic has been transferred between nodes as a result of the occurrence of a traffic changing request, notifying said network management equipment about to which node the right of selecting traffic has been transferred.

12. The ring interconnection network system according to claim 1, further comprising:

network management equipment which provides monitoring control of the system; and

an external command which is given from said network management equipment to each node and which stops said second self-healing function temporarily.

13. The ring interconnection network system according to claim 1, further comprising:

network management equipment which provides

monitoring control of the system; and  
time setting means for causing said network  
management equipment to set in each node the time from  
when a failure occurs in said connection parts until  
5 the process of forming a communication route is started  
at said second self-healing function.

14. The ring interconnection network system  
according to claim 13, wherein said time setting means,  
when a failure has occurred, sets separately the time  
10 elapsed until the process of forming a communication  
route is started at said first self-healing function  
and the time elapsed until the process of forming  
a communication route is started at said second self-  
healing function.

15 15. In a ring interconnection network system  
comprising a plurality of ring networks which have a  
plurality of pieces of node equipment and a  
transmission line connecting these pieces of node  
equipment in a ring and a plurality of connection parts  
20 which connect the plurality of ring networks to each  
other, each piece of said node equipment comprising:

a first self-healing function which, when  
a failure has occurred in said ring networks, forms  
a shortest communication route to avoid the failure;

25 a second self-healing function which, when  
a failure has occurred in said connection parts, forms  
a communication route to avoid the failure; and

switching control means for causing said first self-healing function and said second self-healing function to function in cooperation with each other without contradiction.

5        16. The node equipment according to claim 15,  
further comprising:

10        a function of stopping said second self-healing function temporarily according to an external command from the network management equipment which provides monitoring control of the system.

17. The node equipment according to claim 15,  
further comprising:

15        network management equipment which provides monitoring control of the system; and

20        time setting means for causing the network management equipment which provides monitoring control of the system to set in each node the time from when a failure occurs in said connection parts until the process of forming a communication route is started at said second self-healing function.

18. The node equipment according to claim 17,  
wherein

25        said time setting means, when a failure has occurred, sets separately the time elapsed until the process of forming a communication route is started at said first self-healing function and the time elapsed until the process of forming a communication route is

started at said second self-healing function.

19. Network management equipment which is provided  
in a ring interconnection network system comprising  
a plurality of ring networks which have a plurality of  
5 nodes and a transmission line connecting these nodes  
in a ring and a plurality of connection parts which  
connect the plurality of ring networks to each other  
and which provides monitoring control of said ring  
interconnection network system on the basis of the  
10 notification acquired from each of said plurality of  
nodes, said network management equipment comprising:

a display unit which functions as a human-machine  
interface with the operator and which displays a first  
window to display a pictorial view of the connection  
15 form of each node in the ring interconnection network  
system on the screen of the display unit and shows  
the symbols indicating said transmission lines in the  
pictorial view in such a manner that the symbols are  
distinguished from each other according to the presence  
20 or absence of a failure.

20. The network management equipment according to  
claim 19, wherein said display unit displays a column  
for specifying channel identifiers in each ring network  
arbitrarily on said screen and, when a path correspond-  
25 ing to the channel identifier specified in the column  
exists, shows a symbol indicating the route of the path  
in said first window.

21. The network management equipment according to  
claim 19, wherein said display unit displays a second  
window to show in symbols all the paths existing in  
said ring interconnection network system on the screen  
5 of said display unit.

22. The network management equipment according to  
claim 21, wherein said display unit displays said  
second window together with a scroll button to vary the  
path display range in the second window.

10 23. The network management equipment according to  
claim 21, wherein said display unit displays a column  
for specifying channel identifiers in each ring network  
on said screen and highlights the path corresponding to  
the channel identifier specified in the column.

15 24. The network management equipment according to  
claim 23, wherein, when the path corresponding to said  
specified channel identifier extends over more than one  
ring network, the display unit displays the channel  
identifier corresponding to the path in each ring  
20 network.

25. The network management equipment according to  
claim 20, wherein said display unit displays the  
identifiers for the multiplexed channels of said path  
and the identifiers for the demultiplexed channels.

25 26. The network management equipment according to  
claim 20, wherein said display unit changes the display  
form of the path according to the attribute of the

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path.

27. A path setting method carried out in network management equipment which includes a display unit functioning as a human-machine interface with the operator and is provided in a ring interconnection network system comprising a plurality of ring networks which have a plurality of nodes and a transmission line connecting these nodes in a ring and a plurality of connection parts which connect the plurality of ring networks to each other, said path setting method comprising:

a step of specifying a node to become the starting point of a path to be set and a node to become the end of the path in a first window which shows a pictorial view of the connection form of each node in the ring interconnection network system displayed on the screen of said display unit; and

a step of specifying a path route in the connection parts between ring networks.

28. The path setting method according to claim 27, further comprising a step of stopping a self-healing function in the system when creating the set path in said ring interconnection network system.

29. A path setting method carried out in network management equipment which includes a display unit functioning as a human-machine interface with the operator and is provided in a ring interconnection

network system comprising a plurality of ring networks which have a plurality of nodes and a transmission line connecting these nodes in a ring and a plurality of connection parts which connect the plurality of ring networks to each other, said path setting method comprising:

a step of specifying all the nodes through which a path to be set passes in a first window which shows a pictorial view of the connection form of each node in the ring interconnection network system displayed on the screen of said display unit.

30. A path setting method carried out in network management equipment which includes a display unit functioning as a human-machine interface with the operator and is provided in a ring interconnection network system comprising a plurality of ring networks which have a plurality of nodes and a transmission line connecting these nodes in a ring and a plurality of connection parts which connect the plurality of ring networks to each other, said path setting method comprising:

a first step of specifying a node to become the starting point of a path to be set and a node to become the end of the path;

25 a second step of calculating all the path routes which can be set between the nodes specified in the first step and displaying the calculated path routes in

list form; and

a third step of specifying any one of the path routes listed in the second step in a first window which shows a pictorial view of the connection form of each node in the ring interconnection network system displayed on the screen of said display unit.

31. A ring interconnection network system comprising:

a first, a second, and a third ring network where a plurality of nodes are connected in a ring via a service line and a protection line;

a first interconnection line which connects a first interconnection node in the first ring network and a second interconnection node in the second ring network;

a second interconnection line which connects a third interconnection node adjacent to said first interconnection node in the first ring network and a fourth interconnection node adjacent said second interconnection node in the second ring network;

a third interconnection line which connects a fifth interconnection node adjacent to said third interconnection node in the first ring network and a sixth interconnection node adjacent said fourth interconnection node in the second ring network;

a fourth interconnection line which connects a seventh connection node in the second ring network

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and an eighth interconnection node in said third ring network;

a fifth interconnection line which connects  
a ninth interconnection node adjacent said seventh  
5 interconnection node in the second ring network and  
a tenth interconnection node adjacent to said eighth  
interconnection node in the third ring network; and

a sixth interconnection line which connects  
an eleventh interconnection node adjacent said ninth  
10 interconnection node in the second ring network and  
a twelfth interconnection node adjacent to said tenth  
interconnection node in the third ring network, wherein  
in a case where a communication path extending  
from said first ring network, passing through said  
15 second ring network, and reaching said third ring  
network is set,

when the communication path passes the segment  
between said first ring network and said second ring  
network, the path is caused to pass through at least  
20 two of said first to third interconnection lines, and

when the communication path passes the segment  
between said second ring network and said third ring  
network, the path is caused to pass through at least  
two of said fourth to sixth interconnection lines.

25       32. The ring interconnection network system  
according to claim 31, wherein, when failures have  
occurred in the service line and protection line

between said fourth interconnection node and sixth  
interconnection node, any one of said seventh, ninth,  
and eleventh interconnection nodes sets the route of  
said communication path again for said sixth

5       interconnection node via the protection line opposite  
the fault segment.

33. The ring interconnection network system  
according to claim 31, wherein, when failures have  
occurred in the service line and protection line

10      between said second interconnection node and seventh  
interconnection node, any one of said fourth, sixth,  
ninth, and eleventh interconnection nodes sets the  
route of said communication path again for said second  
interconnection node and said seventh interconnection  
15      node via the protection line opposite the fault  
segment.

34. The ring interconnection network system  
according to claim 31, wherein, when failures have  
occurred in the service line and protection line  
20      between said ninth interconnection node and eleventh  
interconnection node, any one of said second, fourth,  
and sixth interconnection nodes sets the route of said  
communication path again for said eleventh interconnec-  
tion node via the protection line opposite to the fault  
25      segment.

35. The ring interconnection network system  
according to claim 31, wherein, when failures have

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occurred in the service line and protection line  
between said second interconnection node and seventh  
interconnection node and in the service line and  
protection line between said eleventh interconnection  
5 node and sixth interconnection node, the route of said  
communication path is not set again.

36. The ring interconnection network system  
according to claim 31, wherein, when failures have  
occurred in the service line and protection line  
10 between said second interconnection node and fourth  
interconnection node, any one of said sixth, ninth, and  
eleventh interconnection nodes sets the route of said  
communication path again for said fourth interconnec-  
tion node and said seventh interconnection node via  
15 the protection line opposite to the fault segment.

37. The ring interconnection network system  
according to claim 31, wherein, when failures have  
occurred in the service line and protection line  
between said seventh interconnection node and ninth  
20 interconnection node, any one of said fourth, sixth,  
and eleventh interconnection nodes sets the route of  
said communication path again for said second  
interconnection node and said ninth interconnection  
node via the protection line opposite the fault  
25 segment.

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